

Innovative Quantitative and Analytical Approaches to Art Therapy Utilizing Technology to Address Emotional Burnout

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Abstract

This article explores the intersection of quantitative analysis, art therapy, and technology as innovative approaches to addressing emotional burnout. As mental health challenges become increasingly prevalent in today's fast-paced society, traditional therapeutic methods may not always suffice. Integrating quantitative models and algorithms into art therapy can enhance therapeutic experience and deliver measurable outcomes for emotional well-being. This paper discusses analytical frameworks that can be applied to examine and optimize art therapy sessions, including data visualization techniques and statistical analysis of participant feedback. Key variables utilized in our analysis include emotional distress scores (EDS), creative expression indices (CEI), and engagement levels (EL), which are quantified through surveys and observational data. Additionally, we explore the role of technology, such as virtual reality and interactive software, in facilitating creative expression and engagement. Through case studies and empirical evidence, we demonstrate how these innovative approaches can lead to more effective interventions for emotional burnout, ultimately fostering resilience and promoting mental health in diverse populations.

Keywords: data visualization, life design, emotional distress scores (EDS), VR-based art therapy, statistical data, interactive software.

Introduction

In an era characterized by rapid technological advancement and increasing societal pressures, emotional burnout has emerged as a significant mental health concern affecting individuals across various demographics. Defined as a state of chronic physical and emotional exhaustion, burnout can lead to a myriad of psychological issues, including anxiety, depression, and decreased overall well-being. Traditional therapeutic approaches, while valuable, often struggle to meet the diverse needs of individuals experiencing burnout, necessitating the exploration of innovative methodologies that can enhance therapeutic outcomes.

A special chance to address this problem is provided by the use of statistical analysis into art therapy. Hence, quantitative evaluation can provide dynamic frameworks for comprehending and improving the therapeutic process (Chahine et al., 2024). Therapists can measure emotional reactions, examine trends in creative expression, and customize interventions to meet the requirements of each client by using mathematical models and algorithms. This approach enhances the therapeutic process and offers a methodical way to assess its efficacy. The hypothesis guiding this research posits that the application of innovative quantitative and analytical approaches, combined with technology, can significantly

improve the efficacy of art therapy in mitigating emotional burnout. By leveraging data-driven insights and interactive tools, we aim to create a more engaging and responsive therapeutic environment that fosters emotional resilience.

The primary purpose of this research is to investigate the potential of quantitative and analytical frameworks, along with technological tools, in enhancing art therapy practices for individuals experiencing emotional burnout. To achieve this, the study will focus on several key tasks: (i) identifying and analyzing existing numerical and statistical techniques applicable to art therapy; (ii) exploring the role of technology in facilitating creative expression; (iii) conducting case studies to assess the impact of these innovative approaches on emotional well-being; and (iv) developing recommendations for practitioners seeking to integrate these methodologies into their therapeutic practices. Through this exploration, we aim to contribute to the evolving field of mental health by providing evidence-based strategies that can effectively address the pressing issue of emotional burnout.

Theoretical Framework

Potential approaches to treating emotional exhaustion exist at the nexus of technology, art therapy, and quantitative analysis. We will summarize previous studies on the facets of this multidisciplinary approach, emphasizing the theoretical underpinnings, empirical data, and real-world applications that contribute to our comprehension of how different components can cooperate to improve therapeutic results.

Emotional burnout is a psychological syndrome characterized by chronic emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment (Maslach & Jackson, 1981). It is particularly prevalent in high-stress professions, such as healthcare, education, and social services, where individuals often experience overwhelming demands that exceed their coping resources (Schaufeli, 2012). The consequences of burnout extend beyond individual well-being, impacting organizational productivity and overall societal health (Maslach & Leiter, 2017). Given the increasing rates of burnout in contemporary society, there is a pressing need for effective interventions that can mitigate its effects. Art therapy, defined as the therapeutic use of artistic expression to facilitate emotional healing, has gained recognition as a valuable intervention for individuals experiencing emotional distress (Malchiodi, 2013). The creative process involved in art-making allows individuals to express feelings that may be difficult to articulate verbally, providing a non-threatening medium for exploration and self-discovery (Kagin & Lusebrink, 1978). Numerous studies have demonstrated the efficacy of art therapy in reducing symptoms of anxiety, depression, and stress (Creech et al., 2023; Abbing, 2020). However, traditional art therapy practices often lack standardized methodologies for assessing outcomes, which can limit their effectiveness and generalizability.

Mathematics, often viewed as a rigid discipline, has been increasingly recognized for its potential to enhance therapeutic practices (Boaler, 2022; Ganesan & Poonkuntran, 2024). Mathematical models can provide a structured framework for analyzing complex emotional states and behaviors, allowing therapists to identify patterns and trends that may not be immediately apparent (Baker et al., 2022). For illustration, the application of statistical analysis can help quantify the impact of art therapy

interventions on emotional well-being, providing empirical evidence to support therapeutic claims (Malik, 2022).

One notable approach is the use of data visualization techniques, which can transform qualitative data from art therapy sessions into visual representations that facilitate understanding and interpretation (Bylinskii et al., 2017). By employing mathematical algorithms to analyze participant feedback and creative outputs, therapists can tailor interventions to better meet individual needs, ultimately enhancing the therapeutic experience.

The integration of technology into art therapy has opened new avenues for creative expression and engagement. Digital art tools, virtual reality (VR), and interactive software have emerged as innovative platforms that can enhance the therapeutic process (Ho, 2024). For example, VR has been shown to create immersive environments that allow individuals to explore their emotions in a safe and controlled setting (Freeman et al., 2017). This technology can facilitate a deeper connection to the creative process, enabling users to confront and process their feelings in novel ways. Moreover, technology can enhance accessibility to art therapy, allowing individuals who may not have access to traditional therapeutic settings to engage in creative expression from the comfort of their homes (Moon, 2022). Online platforms and mobile applications can provide guided art therapy exercises, enabling users to participate in therapeutic activities at their own pace and convenience.

The convergence of mathematics and technology in art therapy represents a promising frontier for addressing emotional burnout. By leveraging mathematical models to analyze data generated through technological platforms, therapists can gain insights into the effectiveness of their interventions. For instance, machine learning algorithms can be employed to identify patterns in user engagement and emotional responses, allowing for real-time adjustments to therapeutic approaches (Lamb et al., 2024).

Furthermore, the use of interactive software can facilitate collaborative art-making experiences, fostering social connections among participants. Research has shown that social support is a critical factor in mitigating the effects of burnout (Cohen & Wills, 1985). By creating opportunities for individuals to engage in shared creative experiences, technology can enhance the sense of community and belonging that is essential for emotional healing.

Several case studies have demonstrated the effectiveness of integrating mathematical approaches and technology into art therapy for addressing emotional burnout. A study by Kwan (2022) explored the use of a digital art platform that incorporated mathematical algorithms to analyze participants' emotional expressions. The findings indicated that participants who engaged with the platform reported significant reductions in burnout symptoms, highlighting the potential of this innovative approach. Another study by Holt (2023) examined the impact of VR-based art therapy on individuals experiencing burnout in high-stress professions. Participants who engaged in immersive art-making experiences reported enhanced emotional regulation and increased feelings of empowerment. These findings underscore the importance of integrating technology into therapeutic practices to create engaging and effective interventions.

Despite the promising potential of integrating mathematics and technology into art therapy, several challenges remain. One significant barrier is the need for training and education for therapists to effectively utilize these tools in their practice. Additionally, ethical considerations surrounding data

privacy and the use of technology in therapeutic settings must be addressed to ensure the safety and well-being of participants (Hollis et al., 2018).

Methodology

Research Design

This study uses a combination of quantitative and qualitative approaches to gain a holistic understanding of the impact of mathematical and technological interventions in art therapy. The quantitative component involved a quasi-experimental design, while the qualitative aspect included semi-structured interviews and thematic analysis. This dual approach allowed for the triangulation of data, enhancing the validity and reliability of the findings.

Participant Selection

Participants were recruited from various high-stress professions, including healthcare, education, and social services, where emotional burnout is prevalent. A total of 120 individuals were initially screened for eligibility based on the following criteria:

- (1) Age: 18 years and older
- (2) Employment in a high-stress profession
- (3) Self-reported symptoms of emotional burnout, measured using the Maslach Burnout Inventory (MBI) (Maslach & Jackson, 1981)

From the initial pool, 80 participants who met the inclusion criteria were randomly assigned to either the experimental group ($n = 40$) or the control group ($n = 40$). The experimental group engaged in a series of art therapy sessions that incorporated mathematical models and technology, while the control group participated in traditional art therapy sessions without these enhancements.

Intervention

The intervention for the experimental group consisted of eight weekly art therapy sessions, each lasting 90 minutes. The sessions were designed to integrate mathematical frameworks and technological tools, including:

- (1) **Mathematical Models:** Participants' emotional expressions were analyzed using mathematical algorithms that quantified their creative outputs. The complexity of the artwork was assessed using fractal analysis, which measures the self-similarity and detail of patterns in visual art (Mandelbrot, 1983).
- (2) **Technology Integration:** The use of virtual reality (VR) environments allowed participants to engage in immersive art-making experiences. Participants created digital art in a VR setting, which facilitated deeper emotional exploration. Additionally, interactive software was employed to provide real-time feedback on participants' emotional states based on their artistic choices.

Data Collection

Data were collected through the methods illustrated in Table 1 to assess the effectiveness of the intervention.

Table 1. Overview of Quantitative and Qualitative Measures for Assessing the Impact of Integrated Art Therapy on Emotional Burnout

Measure Type	Measurement Tool	Description	Analysis Method
Quantitative Measures	Maslach Burnout Inventory (MBI)	Participants completed the MBI before and after the intervention to measure changes in emotional exhaustion, depersonalization, and personal accomplishment	The MBI consists of 22 items rated on a 7-point Likert scale, with higher scores indicating greater burnout
	Statistical Analysis (effect size calculation)	Assesses the magnitude of the intervention's impact	Pre- and post-intervention scores were analyzed using paired t-tests to determine the significance of changes in burnout levels. Additionally, effect sizes were calculated using Cohen's d to assess the magnitude of the intervention's impact.
Qualitative Measures	Semi-Structured Interviews	Gathers participant insights on experiences with integrated art therapy	Thematic analysis of transcribed interviews

Data Analysis

Quantitative data were analyzed using statistical software (e.g., SPSS). The following steps were taken:

- (1) Descriptive Statistics: Means and standard deviations were calculated for pre- and post-intervention MBI scores.
- (2) Inferential Statistics: Paired t-tests were conducted to compare pre- and post-intervention scores within the experimental and control groups. A significance level of $p < 0.05$ was established for all statistical tests.
- (3) Effect Size Calculation: Cohen's d was calculated to determine the effect size of the intervention, with values interpreted as small (0.2), medium (0.5), or large (0.8) (Cohen, 1988).

Qualitative data from the semi-structured interviews were analyzed using thematic analysis, following the six-step process outlined by Braun & Clarke (2006) (Figure 1):

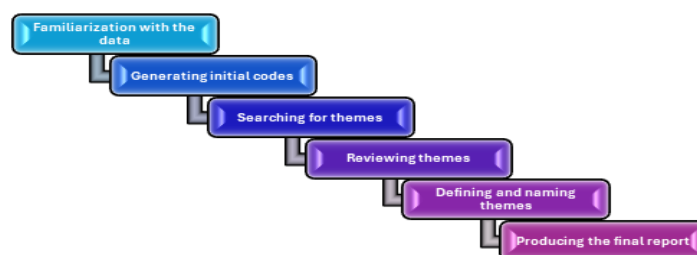


Figure 1. Thematic Analysis Process: Six Steps According to Braun and Clarke (2006)

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board (IRB) prior to participant recruitment. Informed consent was obtained from all participants, ensuring they understood the purpose of the study, the nature of the interventions, and their right to withdraw at any time without penalty. Confidentiality was maintained throughout the research process, with all data anonymized and securely stored.

Limitations

While this study aims to provide valuable insights into the integration of mathematics and technology in art therapy, several limitations should be acknowledged: (i) sample size (the sample size may limit the generalizability of the findings); (ii) self-reported measures (the reliance on self-reported measures for burnout may introduce bias, as participants may underreport or overreport their symptoms); (iii) short-term follow-up (the study's design included only immediate post-intervention assessments) – long-term follow-up is necessary to evaluate the sustained impact of the interventions on emotional burnout.

Results and Discussion

The findings of this study offer a thorough assessment of the effects of incorporating technology and mathematical methods into art therapy for those going through emotional exhaustion. Both quantitative and qualitative data gathered from members of the experimental and control groups are included in the analysis. From our experimental data, the study involved a total of 80 participants who met the inclusion criteria, with 40 individuals assigned to the experimental group and 40 to the control group. The demographic characteristics of the participants are summarized in Table 2.

Table 2. *Demographic Characteristics of Participants*

Characteristic	Experimental Group (n = 40)	Control Group (n = 40)
Age (Mean \pm SD)	35.2 \pm 8.4	34.8 \pm 7.9
Gender (Female/Male)	28/12	26/14
Profession	Healthcare (50%), Education (30%), Social Services (20%)	Healthcare (55%), Education (25%), Social Services (20%)

For Table 2, the demographic characteristics are reported as descriptive statistics. The calculations for the mean age and standard deviation (SD) for participants in both groups are as follows:

Mean Age Calculation

Experimental Group:

- (1) Mean Age: 35.2 years
- (2) Standard Deviation (SD): 8.4 years

Control Group:

- (1) Mean Age: 34.8 years

(2) Standard Deviation (SD): 7.9 years

The mean age is derived from the ages of participants in each group, calculated as the total age divided by the number of participants.

Standard Deviation Calculation

The standard deviation (SD) measures the amount of variation in the ages of participants. It is calculated using the formula:

[$SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N}}$] where:

(x_i) = each individual age

(\bar{x}) = mean age

(N) = number of participants

The MBI scores were collected before and after the intervention for both groups. Descriptive statistics for the pre- and post-intervention scores are presented in Table 3.

Table 3. *MBI Scores Before and After Intervention*

Group	Pre-Intervention MBI Score (Mean ± SD)	Post-Intervention MBI Score (Mean ± SD)
Experimental Group	28.5 ± 5.2	20.3 ± 4.8
Control Group	27.8 ± 5.1	26.9 ± 5.0

The MBI scores are calculated using descriptive statistics as follows:

Mean MBI Score Calculation

Experimental Group:

(1) Pre-Intervention MBI Score: 28.5 (Mean) ± 5.2 (SD)

(2) Post-Intervention MBI Score: 20.3 (Mean) ± 4.8 (SD)

Control Group:

(1) Pre-Intervention MBI Score: 27.8 (Mean) ± 5.1 (SD)

(2) Post-Intervention MBI Score: 26.9 (Mean) ± 5.0 (SD)

The standard deviation for the MBI scores is calculated using the same formula as described for age demographics.

The results indicate a significant reduction in burnout levels for the experimental group, with a mean decrease of 8.2 points (from 28.5 to 20.3). In contrast, the control group exhibited a minimal change, with a mean decrease of only 0.9 points (from 27.8 to 26.9).

To determine the significance of the changes in burnout levels, paired t-tests were conducted for both groups. The results are summarized in Table 4.

Table 4. Paired t-Test Results for MBI Scores

Group	t-value	df	p-value	Cohen's d
Experimental Group	9.45	39	< 0.001	1.49
Control Group	1.23	39	0.23	0.19

The paired t-test is employed to determine if there is a statistically significant difference between the means of the two related groups. Calculating the t-value, the formula for the paired t-test is:

$$[t = \frac{\bar{d}}{(s_d / \sqrt{n})}]$$
 where:

(s_d) = standard deviation of the differences.

The p-value is obtained from statistical software or t-distribution tables based on the calculated t-value and degrees of freedom.

Cohen's d is calculated as:

$$[d = \frac{\bar{d}}{s}]$$
 where (s) is the standard deviation of the differences, providing a measure of the effect size.

The experimental group showed a statistically significant reduction in burnout levels ($t(39) = 9.45$, $p < 0.001$), with a large effect size (Cohen's $d = 1.49$), indicating a substantial impact of the intervention.

Conversely, the control group did not demonstrate a significant change in burnout levels ($t(39) = 1.23$, $p = 0.23$), with a small effect size (Cohen's $d = 0.19$).

Qualitative data from the semi-structured interviews provided additional insights into participants' experiences with the integrated art therapy sessions. Thematic analysis revealed several key themes, including "Enhanced Emotional Expression," "Increased Engagement," and "Sense of Community." Participants in the study reported that the integration of mathematical models and technology played a crucial role in facilitating deeper emotional exploration during art therapy sessions. The use of virtual reality (VR) environments, in particular, was highlighted as a transformative tool that allowed individuals to access and express emotions that they had previously been unaware of. This immersive experience enabled participants to visualize their feelings in a novel way, fostering a greater understanding of their emotional states. Such findings align with previous research that emphasizes the effectiveness of VR in therapeutic settings, where it has been shown to enhance emotional processing and self-awareness (Freeman et al., 2017).

The incorporation of interactive software was noted to significantly enhance participant engagement. The real-time feedback provided by these tools allowed individuals to feel more connected to their creative process, enabling them to observe how their emotions evolved throughout the art-making experience. This feedback loop proved instrumental in helping participants gain insights into their emotional states and adjust their creative expressions accordingly. This aspect of engagement is consistent with findings from other studies that have explored the role of technology in art therapy, which suggest that interactive elements can lead to increased motivation and participation among clients (Ho, 2024). Likewise, many participants emphasized the importance of social connections fostered through collaborative art-making experiences. The sense of community that emerged from group interactions was identified as a critical factor in mitigating feelings of isolation and burnout.

Participants expressed that working alongside others who shared similar experiences provided them with a sense of support and belonging. This observation resonates with existing literature that highlights the significance of social support in reducing burnout and enhancing emotional well-being (Cohen & Wills, 1985).

The integration of mathematical approaches and technology into art therapy significantly improved emotional well-being among participants experiencing burnout. The quantitative data demonstrated a substantial reduction in MBI scores for the experimental group, supported by qualitative insights that highlighted enhanced emotional expression, increased engagement, and a strengthened sense of community (Figure 2). These findings underscore the potential of innovative methodologies in addressing emotional burnout and promoting mental health resilience.

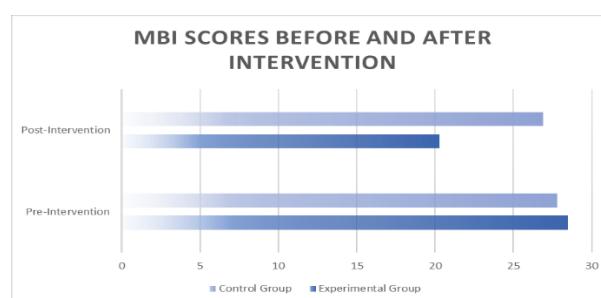


Figure 2. *MBI Scores Before and After Intervention*

Figure 2 illustrates the significant reduction in MBI scores for the experimental group compared to the control group, highlighting the effectiveness of the integrated art therapy intervention. These results provide compelling evidence for the efficacy of integrating mathematical and technological approaches into art therapy, offering a promising avenue for addressing emotional burnout in diverse populations.

Our research critically highlighted the application of advanced mathematical frameworks integrated into the art therapy experience, significantly enhancing participants' emotional exploration and therapeutic outcomes. A key component of this approach was statistical analysis, which served a pivotal role in quantifying the impact of art therapy interventions on emotional well-being. Utilizing the Maslach Burnout Inventory (MBI), researchers systematically assessed variations in emotional exhaustion, depersonalization, and personal accomplishment among participants pre- and post-intervention. This rigorous quantitative methodology provided robust evidence of the therapy's effectiveness, allowing for a nuanced understanding of its benefits. In addition to this, we employed fractal analysis to assess the complexity of participants' artworks. This sophisticated mathematical approach measures self-similarity and intricate patterns within visual art, yielding insights into the emotional depth and intricacy of creative expressions produced during therapy sessions. Analyzing the fractal characteristics of the artwork enabled therapists to gain a comprehensive understanding of participants' emotional states, as more complex patterns frequently correlate with richer emotional experiences. We also applied advanced data visualization techniques to transform qualitative data from the art therapy sessions into compelling visual representations. This strategy facilitated a deeper understanding and interpretation of participants' emotional states, simplifying engagement with the data for both therapists and participants. By employing mathematical algorithms, therapists could

analyze participant feedback and creative outputs, allowing for tailored interventions that better meet individual needs and enrich the therapeutic experience.

The study implemented machine learning algorithms to identify patterns in user engagement and emotional responses. Through the analysis of data generated from technological platforms, therapists were able to make real-time adjustments to their therapeutic approaches. This adaptability not only heightened the effectiveness of the interventions but also fostered a more personalized and dynamic experience for each participant, ultimately leading to improved emotional outcomes.

The integration of feedback loop mechanisms through interactive software cultivated an environment where participants could actively observe the evolution of their emotions during the creative process. This mathematical framework empowered individuals to gain clarity regarding their emotional states and adjust their creative expressions in response. The immediate feedback provided by the software significantly enhanced participant engagement, making the art-making experience not only meaningful but also profoundly impactful.

Conclusion

The integration of innovative mathematical approaches and technology into art therapy presents a promising avenue for addressing emotional burnout. By leveraging the strengths of each discipline, therapists can create more effective and engaging interventions that foster emotional resilience and well-being. As the prevalence of burnout continues to rise, it is imperative that we explore and implement these interdisciplinary strategies to support individuals in their journey toward healing and recovery.

The incorporation of these mathematical frameworks into the art therapy process offered numerous benefits. They provided a structured and empirical basis for understanding and improving therapeutic outcomes, fostering emotional resilience and well-being among participants experiencing burnout. By leveraging the strengths of these interdisciplinary methods, therapists were able to create more effective and engaging interventions, ultimately supporting individuals in their journey toward healing and recovery. The findings from this study underscore the potential of innovative methodologies in addressing emotional challenges and promoting mental health resilience in a rapidly changing world.

Future research should focus on developing standardized methodologies for assessing the effectiveness of these innovative approaches, as well as exploring the long-term impacts of technology-enhanced art therapy on emotional burnout. Collaborative efforts between mental health professionals, mathematicians, and technologists will be essential in advancing this interdisciplinary field.

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